

VOLTAGE MEASUREMENT

FIELD OF THE INVENTION

[0001] The invention relates to voltage measurement and in particular, although not exclusively, to voltage measurement for estimating remaining battery capacity in portable devices.

BACKGROUND TO THE INVENTION

[0002] It is common for portable devices to have a rechargeable battery and charging circuit.

[0003] Remaining battery capacity estimation can be performed in portable devices in a number of different ways. Remaining battery capacity estimation can be achieved using relatively inexpensive hardware although these solutions tend to be fairly inaccurate. This is especially the case for solutions that only rely on battery voltage detection. More accurate battery capacity estimation has required relatively expensive hardware such as current sense amplifiers and/or a dedicated analogue to digital converter or fuel gauge IC.

SUMMARY OF THE INVENTION

[0004] A first aspect of the invention provides apparatus comprising:

- [0005] a charging terminal for connection to a source of charging current;
- [0006] a battery terminal for connection to a battery;
- [0007] a first resistive element;
- [0008] a second resistive element;
- [0009] a switch having a single pole and first and second throws; and
- [0010] a voltage measurement circuit having first and second inputs,

wherein:

- [0011] the first throw of the switch is coupled to a node between the battery terminal and the second resistive element,
 - [0012] the second throw of the switch is coupled to a node between the charging terminal and the first resistive element,
 - [0013] the first resistive element is coupled between the charging terminal and the second resistive element,
 - [0014] the second resistive element is coupled between the battery terminal and the first resistive element,
 - [0015] the second resistive element is coupled between the battery terminal and the first resistive element,
 - [0016] the pole of the switch is coupled to a first input of the voltage measurement circuit,
 - [0017] the second input of the voltage measurement circuit is coupled to a node between the first and second resistive elements, and
 - [0018] the voltage measurement circuit is configured to measure a voltage across its first and second inputs.
- [0019] The switch may comprise a control input and is configured to connect the pole and the second throw together when a charging voltage is present at the charging terminal. The control input of the switch may be coupled to a mid-point of a voltage divider that is coupled between the charging terminal and ground potential. Alternatively, the control input of the switch may be coupled to a controller that is configured to provide a control signal depending on whether charging is or is not required.

[0020] The apparatus may comprise a passing element coupled between the charging terminal and the first resistive element.

[0021] The voltage measurement circuit may comprise a comparator, for example a differential amplifier, having first and second inputs. An output of the comparator may be coupled to an input of an analogue to digital converter.

[0022] The voltage measurement circuit may form part of a power management unit.

[0023] The apparatus may comprise a converter configured to calculate current from signals provided by the voltage measurement circuit.

[0024] The apparatus may comprise an integrator configured to integrate measured voltage or calculated current. The apparatus may comprise a battery level calculation module configured to use the integrated voltage or current to calculate remaining capacity of a battery coupled to the battery terminal.

[0025] A second aspect of the invention provides a portable device comprising apparatus as above.

[0026] A third aspect of the invention provides a method of operating apparatus comprising:

- [0027] a charging terminal for connection to a source of charging current;
- [0028] a battery terminal for connection to a battery;
- [0029] a first resistive element;
- [0030] a second resistive element;
- [0031] a switch having a single pole and first and second throws; and
- [0032] a voltage measurement circuit having first and second inputs,

wherein:

- [0033] the first throw of the switch is coupled to a node between the battery terminal and the second resistive element,
- [0034] the second throw of the switch is coupled to a node between the charging terminal and the first resistive element,
- [0035] the first resistive element is coupled between the charging terminal and the second resistive element,
- [0036] the second resistive element is coupled between the battery terminal and the first resistive element,
- [0037] the pole of the switch is coupled to a first input of the voltage measurement circuit,
- [0038] the second input of the voltage measurement circuit is coupled to a node between the first and second resistive elements, and
- [0039] the voltage measurement circuit is configured to measure a voltage across its first and second inputs,

the method comprising using the measured voltage to calculate charging and discharging of a battery coupled to the battery terminal.

[0040] A fourth aspect of the invention provides a computer program comprising instructions that when executed by apparatus comprising:

- [0041] a charging terminal for connection to a source of charging current;
- [0042] a battery terminal for connection to a battery;
- [0043] a first resistive element;
- [0044] a second resistive element;
- [0045] a switch having a single pole and first and second throws; and
- [0046] a voltage measurement circuit having first and second inputs,